# PATENT COOPERATION TREATY
# PCT
## INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY
(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

| Applicant's or agent's file reference<br>9869SG216 | **FOR FURTHER ACTION** | See Form PCT/IPEA/416 |
|---|---|---|

| International application No.<br>**PCT/SG2004/000412** | International filing date *(day/month/year)*<br>15 December 2004 | Priority date *(day/month/year)*<br>16 December 2003 |
|---|---|---|

International Patent Classification (IPC) or national classification and IPC

| Int. Cl. | *H04N 17/00* (2006.01)   *G06T 7/40* (2006.01) *H04N 7/30* (2006.01)<br>*G06K 9/52* (2006.01)   *H04N 1/409* (2006.01) |
|---|---|

Applicant

    AGENCY FOR SCIENCE, TECHNOLOGY AND RESEARCH  et al

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1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

3. This report is also accompanied by ANNEXES, comprising:

  a. ☒ *(sent to the applicant and to the International Bureau)* a total of **8** sheets, as follows:

      ☒ sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).

      ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.

  b. ☐ *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s))    , containing a sequence listing and/or table related thereto, in electronic form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

4. This report contains indications relating to the following items:

  ☒ Box No. I      Basis of the report

  ☐ Box No. II     Priority

  ☐ Box No. III    Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

  ☒ Box No. IV    Lack of unity of invention

  ☒ Box No. V     Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

  ☐ Box No. VI    Certain documents cited

  ☐ Box No. VII   Certain defects in the international application

  ☐ Box No. VIII  Certain observations on the international application

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| Date of submission of the demand<br>14 October 2005 | Date of completion of this report<br>20 February 2006 |
|---|---|

| Name and mailing address of the IPEA/AU<br><br>AUSTRALIAN PATENT OFFICE<br>PO BOX 200, WODEN  ACT  2606, AUSTRALIA<br>E-mail address: pct@ipaustralia.gov.au<br>Facsimile No.  (02) 6285 3929 | Authorized Officer<br><br><br>**CHARLES BERKO**<br>Telephone No. (02) 6283 2169 |
|---|---|

Form PCT/IPEA/409 (Cover sheet) (April 2005)

# INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

| Box No. I | Basis of the report |
|---|---|

1.   With regard to the **language**, this report is based on:

☒ The international application in the language in which it was filed

☐ A translation of the international application into                                                                , which is the language of a
translation furnished for the purposes of:

   ☐ international search (under Rules 12.3(a) and 23.1 (b))

   ☐ publication of the international application (under Rule 12.4(a))

   ☐ international preliminary examination (Rules 55.2(a) and/or 55.3(a))

2.   With regard to the **elements** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

☐ the international application as originally filed/furnished

☒ the description:

   pages   **1-21**   as originally filed/furnished
   pages*         received by this Authority on   with the letter of
   pages*         received by this Authority on   with the letter of

☒ the claims:

   pages         as originally filed/furnished
   pages*         as amended (together with any statement) under Article 19
   pages*   **1-8**   received by this Authority on   **20 January 2006**   with the letter of  20 January 2006
   pages*         received by this Authority on   with the letter of

☒ the drawings:

   pages   **1-4**   as originally filed/furnished
   pages*         received by this Authority on   with the letter of
   pages*         received by this Authority on   with the letter of

☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing.

3.   ☐ The amendments have resulted in the cancellation of:

   ☐ the description, pages

   ☐ the claims, Nos.

   ☐ the drawings, sheets/figs

   ☐ the sequence listing *(specify)*:

   ☐ any table(s) related to the sequence listing *(specify)*:

4.   ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

   ☐ the description, pages

   ☐ the claims, Nos.

   ☐ the drawings, sheets/figs

   ☐ the sequence listing *(specify)*:

   ☐ any table(s) related to the sequence listing *(specify)*:

\*      *If item 4 applies, some or all of those sheets may be marked "superseded."*

| Box No. IV | Lack of unity of invention |
|---|---|

1. [X] In response to the invitation to restrict or pay additional fees the applicant has, within the applicable time limit:

    [ ] restricted the claims

    [ ] paid additional fees

    [X] paid additional fees under protest and, where applicable, the protest fee

    [ ] paid additional fees under protest but the applicable protest fee was not paid

    [ ] neither restricted the claims nor paid additional fees

2. [ ] This Authority found that the requirement of unity of invention is not complied with and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is:

    [ ] complied with.

    [X] not complied with for the following reasons:

       See supplemental box

4. Consequently, this report has been established in respect of the following parts of the international application:

    [X] all parts.

    [ ] the parts relating to claims Nos.

| Box No. V | Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement |
|---|---|

**1. Statement**

| | | | |
|---|---|---|---|
| Novelty (N) | Claims | **1-4, 6-20, 22-37** | **YES** |
| | Claims | **5, 21** | **NO** |
| Inventive step (IS) | Claims | **1-4, 7-20, 23-37** | **YES** |
| | Claims | **5, 6, 21, 22** | **NO** |
| Industrial applicability (IA) | Claims | **1-37** | **YES** |
| | Claims | | **NO** |

**2. Citations and explanations (Rule 70.7)**

### 1. Citations

D1: EP 1001608 A (Xerox Corporation), 17 May 2000

D2: Hsieh et al; *On the Entropy Analysis of Greyscale Images*; Proc 19th Asian Conference on Remote Sensing, November 1998 [Hsieh]

### 2. Novelty

1. The invention defined in claims 5 and 21 is not novel when compared with prior art document D1. Document D1, at paragraph 13, discloses taking the absolute differences between adjacent pixels, taking a generalised histogram (i.e. the average) of the crossing and non-crossing blocks and taking the difference between the generalised values; substantially as claimed.

### 3. Inventive Step

1. The invention defined in claims 5 and 21 lacks inventiveness as given above.

2. The invention defined in claims 6 and 22 lacks an inventive step. The present invention utilises the natural logarithm of the respective products of the probabilities of individual colour values, which differs from the prior art in that D2 discloses utilising the logarithmic base 2 function as applied to greyscale images. However, attention is drawn to page 2 paragraph 3 of D2, which specifies that base 2 is selected as a matter of convenience, and that this only affects the units used to measure information. Although D2 does not make any specific references to colour images, D2 discloses a general information analysis theory and a way to calculate the uncertainty or entropy of source information, using greyscale images for illustrative purposes. It is considered that the difference between the claimed invention and D2 constitutes no more than a mere workshop improvement. It is an arrangement that any competent worked in the art would be expected to make directly, without difficulty and by routine steps alone. Therefore the claimed invention does not involve and inventive step.

**Supplemental Box**

In case **the space in any of the preceding boxes is not sufficient.**

Continuation of: Box IV

The international application does not comply with the requirements of unity of invention because it does not relate to one invention or a group of inventions so linked as to form a single general inventive concept. In coming to this conclusion the International Preliminary Examining Authority has found that there are five inventions:

1. Claims 1-4, 15-21 and 33-37, directed to a method and apparatus for determining a measure of an image quality. The combined use of three separate quality measures is considered to be a first "special technical feature".

2. Claims 5, 8, 21, 24 and 32, directed to a method and apparatus for determining a blockiness measure of an image. The calculation of the measure from pixel differences both at block boundaries and within blocks is considered to be a second "special technical feature".

3. Claims 6, 9, 22 and 25, directed to a method and apparatus for determining a colour richness measure of an image. The use of an entropy-style formulation with colour values is a third "special technical feature".

4. Claims 7, 10, 23 and 26, directed to a method and apparatus for determining a sharpness measure of an image. The use of an entropy-style formulation with colour difference values is a fourth "special technical feature".

5. Claims 11-14 and 27-31, directed to a method and apparatus for determining a motion activity measure for an image sequence. The use of an entropy-style formulation with image sequence difference values is a fifth "special technical feature". (Claims 11 and 27 may be appended to many independent claims in the previous groups. However, the only feature which persists in all these variations is the use of motion activity metric, which relates to this group of claims. Consequently claims 11 and 27 are included here.)

Since the abovementioned groups of claims do not share any technical features, a "technical relationship" between the inventions, as defined in PCT rule 13.2, does not exist. Accordingly, the international application does not relate to one invention or to a single inventive concept. (It is noted that, while the first group of claims includes reference to blockiness, colour and sharpness measures, these generic features, per se, are well-known and cannot be "special technical features" relating the first invention to any others).

# CLAIMS

1.  Apparatus for determining a measure of image quality of an image, comprising:

    means for determining a blockiness invisibility measure of the image;

    means for determining a colour richness measure of the image;

    means for determining a sharpness measure of the image; and

    means for providing the measure of image quality of the image based on respective products of the blockiness invisibility measure, the colour richness measure and the sharpness measure of the image with respective attenuation factors.

2.  Apparatus according to claim 1, wherein the means for determining the colour richness measure of the image is operable to provide the colour richness based on the sum of respective products of the probabilities of colour values and the logarithms, using $e$ as a base, of those probabilities.

3.  Apparatus according to claim 1 or 2, wherein the means for determining the sharpness measure of the image is operable to provide the sharpness based on the sum of respective products of the probabilities of differences in a plurality of colour channel values between neighbouring portions of the image and the logarithms of those probabilities.

4.  Apparatus according to claim 3, wherein the differences between neighbouring portions of the image are differences in image data between neighbouring pixels.

5.  Apparatus for determining a blockiness invisibility measure of an image, comprising:

    means for averaging differences in colour values at block boundaries within the image;

means for averaging differences in colour values between adjacent pixels; and

means for providing the blockiness invisibility measure based on a relative strength of the averaged differences in colour values at block boundaries within the image with respect to the averaged differences in colour values between adjacent pixels.

6.      Apparatus for determining a colour richness measure of an image, comprising:

        means for determining the probabilities of individual colour values within the image;

        means for determining respective products of the probabilities of individual colour values and the logarithms, using e as a base, of the probabilities of individual colour values; and

        means for providing the colour richness measure based on the sum of the respective products of the probabilities of individual colour values and the logarithms, using e as the base, of the probabilities of individual colour values.

7.      Apparatus for determining a sharpness measure of an image, comprising:

        means for determining differences in a plurality of colour values between adjacent pixels within the image;

        means for determining respective probabilities of individual colour channel value differences within the image;

        means for determining respective products of the probabilities of individual colour value differences and the logarithms of the probabilities of individual colour value differences; and

        means for providing the sharpness measure based on the sum of the respective products of the probabilities of individual colour value differences and the logarithms of the probabilities of individual colour value differences.

8.      Apparatus according to any one of claims 1 to 4, wherein the means for determining a blockiness invisibility measure of the image comprises apparatus according to claim 6.

9.      Apparatus according to any one of claims 1 to 4 and 8, wherein the means for determining a colour richness measure of the image comprises apparatus according to claim 6.

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10.     Apparatus according to any one of claims 1 to 4, 8 and 9, wherein the means for determining a sharpness measure of the image comprises apparatus according to claim 7.

10  11.     Apparatus for determining a measure of image quality of an image within a sequence of two or more images, comprising:

apparatus according to any one of claims 1 to 4 and 8 to 10; and

means for determining a motion activity measure of the image within the sequence of images.

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12.     Apparatus for determining a motion activity measure of an image within a sequence of two or more images, comprising:

means for determining differences in a plurality of colour values between pixels within the image and corresponding pixels in a preceding image within the

20  sequence of images;

means for determining respective probabilities of individual colour value differences between the image and the preceding image;

means for determining respective products of the probabilities of individual colour value differences and the logarithms of the probabilities of

25  individual colour value differences; and

means for providing the motion activity measure based on the sum of the respective products of the probabilities of individual colour value differences and the logarithms of the probabilities of individual colour value differences.

30  13.     Apparatus according to claim 11, wherein the means for determining a motion activity measure of the image within the sequence of images comprises apparatus according to claim 12.

14.    Apparatus according to claim 11 or 13, wherein the means for providing the measure of image quality of the image is operable to provide the image quality measure further based on the motion activity measure of the image.

5    15.    Apparatus for determining a measure of video quality of a sequence of two or more images, comprising:

apparatus according to any one of claims 1 to 4, 8 to 11, 13 and 14; and

means for providing the measure of video quality based on an average of the image quality for a plurality of images within the sequence of two or more

10    images.

16.    Apparatus according to any one of the preceding claims, operable to make the determination without reference to a reference image.

15    17.    A method of determining a measure of image quality of an image, comprising:

determining a blockiness invisibility measure of the image;

determining a colour richness measure of the image;

determining a sharpness measure of the image; and

20    providing the measure of image quality of the image based on respective products of the blockiness invisibility measure, the colour richness measure and the sharpness measure of the image with respective attenuation.

18.    A method according to claim 18, wherein determining the colour richness

25    measure of the image comprises providing respective colour richness based on the sum of the products of the probabilities of colour values and the logarithms using e as a base, of those probabilities.

19.    A method according to claim 18 or 19, wherein determining the sharpness

30    measure of the image comprises providing the sharpness based on the sum of respective products of the probabilities of differences in a plurality between neighbouring portions of the image and the logarithms of those probabilities.

20.     A method according to claim 19, wherein the differences between neighbouring portions of the image are differences in image data between neighbouring pixels.

5   21.     A method for determining a blockiness invisibility measure of an image, comprising:

averaging differences in colour values at block boundaries within the image;

averaging differences in colour values between adjacent pixels; and

10      providing the blockiness invisibility measure based on a relative strength of the averaged differences in colour values at block boundaries within the image with respect to the averaged differences in colour values between adjacent pixels.

22.     A method for determining a colour richness measure of an image,
15  comprising:

determining the probabilities of individual colour values within the image;

determining the respective products of the probabilities of individual colour values and the logarithms using e as a base, of the probabilities of individual colour values; and

20      providing the colour richness measure based on the sum of the respective products of the probabilities of individual colour values and the logarithms using e as a base, of the probabilities of individual colour values.

23.     A method for determining a sharpness measure of an image, comprising:
25      determining differences in a plurality of colour channel values between adjacent pixels within the image;

determining respective probabilities of individual colour value differences within the image;

determining respective products of the probabilities of individual colour
30  value differences and the logarithms of the probabilities of individual colour value differences; and

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providing the sharpness measure based on the sum of the respective products of the probabilities of individual colour value differences and the logarithms of the probabilities of individual colour value differences.

5    24.    A method according to any one of claims 17 to 20, wherein determining a blockiness invisibility measure of the image comprises a method according to claim 21.

25.    A method according to any one of claims 17 to 20 and 24, wherein
10    determining a colour richness measure of the image comprises a method according to claim 22.

26.    A method according to any one of claims 17 to 20, 24 and 25, wherein determining a sharpness measure of the image comprises a method according to
15    claim 23.

27.    A method for determining a measure of image quality of an image within a sequence of two or more images, comprising:
         a method according to any one of claims 17 to 20 and 24 to26; and
20         determining a motion activity measure of the image within the sequence of images.

28.    A method for determining a motion activity measure of an image within a sequence of two or more images, comprising:
25         determining differences in a plurality of colour channel values between pixels within the image and corresponding pixels in a preceding image within the sequence of images;
         determining respective probabilities of individual colour value differences between the image and the preceding image;
30         determining respective products of the probabilities of individual colour value differences and the logarithms of the probabilities of individual colour value differences; and

providing the motion activity measure based on the sum of the respective products of the probabilities of individual colour value differences and the logarithms of the probabilities of individual colour value differences.

5   29.      A method according to claim 27, wherein determining a motion activity measure of the image within the sequence of images comprises a method according to claim 28.

    30.      A method according to claim 27 or 29, wherein providing the measure of
10   image quality of the image comprises providing the image quality measure further based on the motion activity measure of the image.

    31.      A method for determining a measure of video quality of a sequence of two or more images, comprising:
15              a method according to any one of claims 17 to 20, 24 to 27, 29 and 30; and
              providing the measure of video quality based on an average of the image quality for a plurality of images within the sequence of two or more images.

20   32.      A method according to any one of the claims 17 to 31, wherein the determination is made without reference to a reference image.

    33.      A method of determining a measure of video or image quality substantially as hereinbefore described with reference to and as illustrated in the
25   accompanying drawings.

    34.      Apparatus according to any one of claims 1 to 16 operable in accordance with the method of any one of claims 17 to 33.

30   35.      Apparatus for determining a measure of video or image quality constructed and arranged substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

36.     A computer program product having a computer usable medium having a computer readable program code means embodied therein for determining a measure of video or image quality, the computer program product comprising:
        computer readable program code means for operating according to the
5       method of any one of claims 17 to 33.


37.     A computer program product having a computer usable medium having a computer readable program code means embodied therein for determining a measure of video or image quality, the computer program product comprising:
10      computer readable program code means which, when downloaded onto a computer renders the computer into apparatus according to any one of claims 1 to 16, 34 and 35.